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THE DEVELOPMENT OF ACHIEVEMENT MEASURES FOR TRADE AND TECHNICAL EDUCATION. PROGRESS REPORT NUMBER FIVE.

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DESCRIPTORS- *ACHIEVEMENT TESTS, *TEST CONSTRUCTION, *TRADE AND INDUSTRIAL EDUCATION, *PERFORMANCE TESTS, TECHNICAL EDUCATION, RESEARCH PROJECTS, CURRICULUM, ELECTRONICS, ELECTRONIC DATA PROCESSING, TESTING PROGRAMS, COGNITIVE TESTS,

TWO FORMS OF PAPER AND PENCIL ACHIEVEMENT TESTS WERE ASSEMBLED IN FOUR AND ONE FORM WAS ASSEMBLED IN THE OTHER OF THE FIVE TRADE CURRICULUM AREAS IN WHICH THE PROJECT IS DEVELOPING ACHIEVEMENT MEASURES. DESIGN AND PRODUCTION OF 10 OF THE 12 MEASURES OF PERFORMANCE FOR THE FIVE AREAS WERE COMPLETED. NINE HOURS OF TESTING TIME WERE REQUESTED OF THE PARTICIPATING INSTITUTIONS FOR ADMINISTERING THE PAPER AND PENCIL PERFORMANCE AND REFERENCE TESTS, AND TESTING WAS BEGUN. TESTS IN THE TWO TECHNOLOGIES INCLUDED IN THE PROJECT WERE ADMINISTERED TO 179 STUDENTS IN ELECTRONIC DATA PROCESSING AND TO 338 STUDENTS IN ELECTRONICS TECHNOLOGY IN 29 INSTITUTIONS IN FIVE DIFFERENT STATES. TO IDENTIFY THE FACTORS ISOLATED THROUGH FACTOR ANALYSIS, SEVERAL TESTS WHICH MEASURE RELATIVELY PURE FACTORS OF INTELLIGENCE ARE TO BE USED IN THE PROJECT TESTING PROGRAM. THESE WERE SELECTED FROM THE "KIT OF REFERENCE TESTS FOR COGNITIVE FACTORS", DESCRIBED IN THE APPENDIX. A DESCRIPTION OF EACH PERFORMANCE TEST IS INCLUDED. OTHER PROGRESS REPORTS ARE VT 003 205, VT 003 315, VT 003 699, AND VT 005 199. (HC)

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THE DEVELOPMENT OF ACHIEVEMENT MEASURES FOR TRADE AND TECHNICAL EDUCATION

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SUMMARY OF PROGRESS REPORT NO. 5

During this report period, assembly of Achievement Tests in the five trade curricula in which the project is developing achievement measures was completed. Two forms of pencil and paper achievement tests were assembled in four of the curricula while one form was assembled for the remaining curriculum. Design and production of ten of the twelve measures of performance for the five curricula was completed. Nine hours of testing time has been requested of all participating institutions for administration of pencil and paper, performance and reference tests.

Contained in this report is a summary of all tests being used in the testing program undertaken by this project. Included also are brief descriptions of performance tests and reference tests.

During this report period, testing in the two technologies included in this project was begun and completed. Testing was undertaken in twenty-nine different institutions in five different states. The states were Connecticut, Georgia, New Jersey, North Carolina and South Carolina. Samples in each state ranged from a small percentage to almost all of the testable population. A total of 179 students was tested in Electronics Data Processing, and a total of 338 students was tested in Electronics Technology.

Testing was begun in the five trade curricula, but the preponderance of testing in these curricula will occur in late July and early August.

Since the last progress report period, which ended 2 March, the primary emphasis of the project has been on the production and administration of the preliminary forms of the achievement tests. As detailed in the previous progress report, tests in the two technologies were completed and made ready for administration during that report period. Since that time, tests in the five trade areas have also been developed, reproduced, assembled and made ready for administration. In each of the seven curricula in which the project is working, with the exception of Air Conditioning, Heating and Refrigeration, two forms of each paper and pencil test have been developed. It was the opinion of the staff that in the Air Conditioning, Heating and Refrigeration curriculum insufficient test material was available to develop two forms of the test. Therefore, all efforts in that curriculum were devoted to the development of one form of the paper and pencil achievement test.

As detailed in a previous progress report, one of the statistical techniques to which each achievement test developed by the project will be subjected is a factor analysis. The purpose of this factor analysis will be to isolate the actual number of factors being measured by the test. In order to identify the factors isolated through factor analysis, it was decided that several tests which measure relatively pure factors of intelligence should be administered along with the achievement tests. A thorough examination of tests available in print and a review of existing literature led the staff to a battery of research instruments entitled "Kit of Reference Tests for Cognitive Factors." This Kit contains approximately seventy-five tests which are supposed to be relatively pure measures of twenty-four different cognitive factors. Appendix A contains a complete report by the staff on the "Kit of Reference Tests for Cognitive Factors" with an indication of the tests selected for use in the testing program conducted by this project.

Now that the development of all achievement tests, both pencil and paper and performance, and selection of the reference tests to be used in the testing program have been completed, a detailed explanation of all tests developed by the project and all reference tests selected for administration is presented. Pages 3, 4, and 5 contain a breakdown of all tests used in each of the seven curricula included in this research project. Included also are the title of each test administered in each curriculum, either pencil and paper, performance, or reference. It has been mentioned in a previous progress report that six hours of testing time was set aside for administration of the pencil and paper achievement test and the selected reference tests which accompany each achievement test. Also an additional three hours of testing was made available for the administration of performance tests. A study of the next several pages will reveal why this considerable amount of time was necessary.

Pages 6 and 7 of this report contain a complete breakdown of the pencil and paper achievement measures developed by the project. The breakdown includes the number of parts (subtests) of each test, the number of forms developed in each area, the number of items on each form of the test, the time limit for each part of the test, and the curriculum area which each particular part of the test samples. The weighting of each subtest in terms of time allocation and number of items was done by expert judgment and consensus of the field consultant committee.

The performance tests for the various curricula consist of certain subtests which attempt to measure directly the level of performance attained. Others of the subtests attempt to measure psychomotor or tactile-kinesthetic performance which are thought to contribute to a student's ability to perform. A description of each performance test is contained in Appendix B.

TESTS USED IN ACHIEVEMENT MEASURES TESTING PROGRAM

Curriculum	Achievement Test	Performance Test	Reference Test
Electronic Data Processing (EDP)	1. Achievement Test for Data Processing Technology		1. Ship Destination Test (R)* 2. Subtraction & Multiplication Test (N) 3. Wide Range Vocabulary Test (V) 4. Number Comparison Test (P) 5. Inference Test (Rs) 6. Word Endings Test (Fw) 7. Symbol Production Test (O)
Electronics (ELN)	1. Achievement Test for Electronics Technology		1. Ship Destination Test (R) 2. Subtraction & Multiplication Test (N) 3. Wide Range Vocabulary Test (V) 4. Number Comparison Test (P) 5. Inference Test (Rs)
Automotive Mechanics (AUTO)	1. Achievement Test for Automotive Mechanics 2. Tool Identification Test for Automotive Mechanics 3. Engine Diagnostic Test for Automotive Mechanics	1. Plug & Ring Gauge Test 2. Measurement Pod Test 3. Electrical Trouble-Shooting Test for Automotive Mechanics 4. Dynamometer 5. Tactile-Kinesthetic Sensitivity Test 6. Dynamic Scope Test 7. Auditory Achievement Test for Automotive Mechanics	1. Mechanical Information Test (Mk) 2. Subtraction & Multiplication Test (N) 3. Inference Test (Rs) 4. Cube Comparison Test (S) 5. Number Comparison Test (P) 6. Wide Range Vocabulary Test (V) 7. Surface Development Test (Vz)

*Cognitive factor measured - as defined in Appendix A

Curriculum	Achievement Test	Performance Test	Reference Test
Air Conditioning, Heating and Refrigeration (AHR)	1. Achievement Test for Air Conditioning, Heating, and Refrigeration	1. Tactile-Kinesthetic Sensitivity Test 2. Plug & Ring Gauge Test 3. Dynamometer	1. Mechanical Information Test (Mk) 2. Subtraction & Multiplication Test (N) 3. Inference Test (Rs) 4. Cube Comparison Test (S) 5. Wide Range Vocabulary Test (V) 6. Surface Development Test (Vz) 7. Figure Classification Test (I)
Machinist (MACH)	1. Achievement Test for Machinist Trade	1. Plug & Ring Gauge Test 2. Machine Indexing Test for Machinists 3. Truing Test for Machinist 4. Measurement Pod Test 5. Tactile-Kinesthetic Sensitivity Test 6. Dynamometer 7. Auditory Achievement Test for Machinists	1. Mechanical Information Test (Mk) 2. Subtraction & Multiplication Test (N) 3. Cube Comparison Test (S) 4. Ship Destination Test (R) 5. Wide Range Vocabulary Test (V) 6. Surface Development Test (Vz) 7. Inference Test (Rs)
Radio and Television Repair (R-TV)	1. Achievement Test for Radio and Television Servicing 2. Achievement Test for Television Servicing (Diagnosis of Television malfunctions)	1. Achievement Test for Television Servicing (Diagnosis of Television malfunctions)	1. Mechanical Information Test (Mk) 2. Ship Destination Test (R) 3. Subtraction & Multiplication Test (N) 4. Surface Development Test (Vz) 5. Figure Classification Test (I) 6. Cube Comparison Test (S) 7. Wide Range Vocabulary Test (V) 8. Inference Test (Rs)

Curriculum	Achievement Test	Performance Test	Reference Test
Electrical Installation and Maintenance (EIM)	1. Achievement Test for Electrical Installation and Maintenance (Industrial Electricity)	1. Systematic Comprehensive Review of Electrical Wiring 2. Plug & Ring Gauge Test 3. Dynamometer 4. Tactile-Kinesthetic Sensitivity Test	1. Mechanical Information Test (Mk) 2. Ship Destination Test (R) 3. Subtraction & Multiplication Test (N) 4. Surface Development Test (Vz) 5. Figure Classification (I) 6. Cube Comparison Test (S) 7. Wide Range Vocabulary Test (V) 8. Inference Test (Rs)

BREAKDOWN OF PENCIL AND PAPER ACHIEVEMENT MEASURES

Part of Test	Number of Items Form A	Form B	Time Limit	Area Sampled (Subtest)
Electronic Data Processing (EDP)				
Part I	60	60	50 min.	Data Processing Systems-Concepts
Part II	60	60	90 min.	Data Processing Systems-Applications
Part III	50	50	75 min.	Mathematics and Statistics
Part IV	30	30	25 min.	Accounting
	200	200		
Electronics Technology (ELN)				
Part I	50	50	60 min.	Fundamentals of Electricity
Part II	50	50	50 min.	Fundamentals of Electronics
Part III	50	50	50 min.	Application of Electronics
Part IV	50	50	50 min.	Special Circuitry
Part V	30	30	30 min.	Instrumentation
Part VI	40	40	40 min.	Special Devices and Systems Analysis
	270	270		
Automotive Mechanics (AUTO)				
Part I	19	18	15 min.	Tools, Safety, Related Science
Part II	53	53	50 min.	Engines
Part III	20	20	15 min.	Fuel Systems
Part IV	54	54	50 min.	Electrical Systems
Part V	27	27	20 min.	Chassis and Suspension
Part VI	27	26	20 min.	Braking System
Part VII	16	16	15 min.	Air Conditioning
Part VIII	26	26	20 min.	Power Trains
	242	240		
Machinist (MACH)				
Part I	14	13	10 min.	Safety Procedures
Part II	22	22	20 min.	Hand Tools and Applications
Part III	83	84	70 min.	Measuring Tools and Processes
Part IV	27	26	20 min.	Cutting Tools
Part V	42	41	40 min.	Lathes
Part VI	26	26	20 min.	Milling Machines
Part VII	25	25	20 min.	Grinding Machines
Part VIII	20	21	20 min.	Metallurgy
Part IX	23	23	20 min.	Minor Machines
	282	281		

Part of Test	Number of Items Form A	Form B	Time Limit	Area Sampled (Subtest)
Air Conditioning, Heating and Refrigeration (AHR)				
Part I	44		35 min.	Fundamentals
Part II	75		65 min.	Refrigeration
Part III	76		65 min.	Air Conditioning
Part IV	40		30 min.	Controls
Part V	25		20 min.	Blueprint Reading
Part VI	20		15 min.	Materials, Tools and Equipment
Part VII	20		15 min.	Estimating Controls
	300			
Radio and Television Repair (R-TV)				
Part I	24	23	20 min.	Fundamentals of Direct Current
Part II	40	40	45 min.	Fundamentals of Alternating Current
Part III	22	22	20 min.	Vacuum Tubes
Part IV	17	17	15 min.	Power Supply
Part V	21	20	20 min.	Amplifiers
Part VI	20	23	20 min.	Special Circuits
Part VII	23	23	20 min.	Semi-Conductors
Part VIII	16	15	15 min.	Radio Receiver
Part IX	64	63	60 min.	Television
Part X	9	9	5 min.	Test Equipment and Tools
	256	255		
Electrical Installation and Maintenance (EIM)*				
Part I	45	45	45 min.	Basic Electrical Theory
Part II	60	60	50 min.	Machines and Controls
Part III	45	45	35 min.	Construction Wiring
Part IV	30	30	25 min.	Basic Electronic Theory
Part V	30	30	30 min.	Industrial Electronic Application
Part VI	60	60	60 min.	Electrical Malfunctions
Part VII	30	26	20 min.	Safety, Personal and Equipment
	300	296		

*In some states this curriculum is titled Industrial Electricity, in others, Industrial Electronics

During this report period, administration of the preliminary forms of the achievement tests in Electronics Technology and Electronics Data Processing has been completed in five states. Samples from the various states range from a very small percentage of the testable population to practically the entire testable population. In the States of Connecticut, North Carolina and South Carolina, practically all students scheduled to graduate at the end of the spring quarter or semester in the two technologies were tested. In North Carolina, two of the four institutions offering Electronics Data Processing graduated their students at the end of the winter quarter. Since the achievement tests were not ready for administration at that time, over half of the testable sample was lost in that state. One institution in the Georgia system of post-high school technical education participated in the technology testing, also, one technical-vocational high school in New Jersey participated in the Electronics Technology achievement test. Table 1 below gives a detailed explanation of the total sample for this spring's administration of the two technology achievement tests.

Table 1. Breakdown of Testing Sample in Electronics and Electronics Data Processing--By State

State	Number of Institutions*	Number of Students	
		Electronics	Data Processing
Connecticut	4	115	73
Georgia	1	6	16
New Jersey	1	7	-
North Carolina	17	143	44
South Carolina	6	67	46
Totals	29	338	179

*Not all institutions offered both technologies

Not all states operate their trade programs on the same system as do North and South Carolina. The vast majority of trade training in these two states is done on a four quarter, one year, post-high school basis. Students enter in the fall and are graduated in late August. Georgia operates its post-high school trade training on a six quarter basis and graduates its students in early June. Other states, such as Connecticut, Delaware and New Jersey offer their vocational (trade) training in the technical vocational high schools and have separate post-high school institutions for technical training. The project staff deemed it desirable to test in these different environments to ascertain whether or not the students trained under these different circumstances came from different statistical populations. The vocational-technical high schools in Connecticut were already participating in a university sponsored testing program which precluded their participation in this project. As previously indicated, the post-high school technical institutes did participate in the testing in the two technologies.

Testing was begun in the five trade areas in late May in some of the above described situations. The same institution in Georgia which participated in the technology testing participated in testing in all five trade areas. The technical-vocational high school for the City of Wilmington, Delaware also participated in the trade testing program. The county systems of technical-vocational high schools in three New Jersey counties were asked to participate in the project. Two of the county systems agreed to participate, the third declined.

The majority of testing in the trade curricula will take place in North and South Carolina in late July and early August. Two other states have been approached about late summer testing, but to this point, we have no firm

commitment from them. Details of the trade testing program will be outlined in a subsequent progress report. In fact, the major emphasis for the next report period will be directed toward the completion of the achievement testing in the trade curricula.

APPENDIX A

Kit of Reference Tests for Cognitive Factors

Developed by
Educational Testing Service
Princeton, N. J.

In various research over the last several years, many separate factors of aptitude and achievement have been identified. In 1951, Educational Testing Service (ETS) began a project to select those factors which could be agreed upon as measuring separate facets of aptitude or achievement and to develop instruments which would measure these factors. In 1958, the Office of Naval Research began supporting the effort. Using committees of the most respected researchers in the United States, ETS led the activity which resulted in the selection of twenty-four factors which were considered to be independent facets of aptitude and the naming of more than seventy tests deemed suitable for measuring these factors. Each factor has at least three tests designed for different grade levels or using different approaches to measurement of the aptitude factor. The purpose of the Kit is best defined by the authors themselves. In their words:

> The purpose of the Kit is to provide research workers with a set of tests for defining each of these factors. It is intended that use of the Kit tests for this purpose will facilitate interpretation and the confident comparison of one factor study with another. In the past it has often been necessary to cross-identify the factors in two studies by means of psychological interpretation alone, sometimes without any tests common to the two studies. It is undesirable that this kind of subjective identification prevail. There are now in existence several techniques for objectively comparing a factor found in one analysis with that found in another. All methods of this kind require sets of tests that are common to the two studies. Use of the Kit tests should provide this common ground for the objective comparison of factors.

Some of the factors identified in the Kit have only been isolated in laboratory research while others of the factors have been readily identified in field research. The following pages describe the twenty-four factors and list the tests designed to measure them. Asterisks indicate those factors which this project staff and other expert opinion felt to be contained in achievement in trade and technical education and were subsequently used in this testing program as a means of factor identification.

Factors and Tests

Factor Cf: **Flexibility of Closure**

The ability to keep one or more definite configurations in mind so as to make identification in spite of perceptual distractions.

Tests:
- Hidden Figures Test
- Hidden Patterns Test
- Copying Test

Factor Cs: **Speed of Closure**

The ability to unify an apparently disparate perceptual field into a single percept. In this factor the subject does not know what he is looking for.

Tests:
- Gestalt Completion Test
- Concealed Words Test

Factor Fa **Associational Fluency**

The ability to produce words from a restricted area of meaning. This factor involves an awareness of some similarity in the meanings of words amid the difference.

Tests:
- Controlled Association Test
- Association Fluency I
- Associations IV

Factor Fe: **Expressional Fluency**

The ability to think rapidly of appropriate wording for ideas. The emphasis in these tests is on facility in producing connected discourse that will fit restrictions imposed in terms of given ideas, words, or letters.

Tests:
- Expressional Fluency
- Word Arrangements
- Simile Interpretations

Factor Fi: Ideational Fluency

The facility to call up ideas wherein quantity and not quality of ideas is emphasized.

Tests: Topics Test
Theme Test
Thing Categories Test

***Factor Fw:** Word Fluency

The facility in producing isolated words that contain one or more structural, essentially phonetic, restrictions, without reference to the meaning of the words.

Tests: Word Beginnings and Endings Test
****Word Endings Test**
Word Beginnings Test

***Factor I:** Induction

Associated abilities involved in the finding of general concepts that will fit sets of data, the forming and trying out of hypotheses.

Tests: Letter Sets Test
****Figure Classification**
Location Test

Factor Le: Length Estimation

The ability to judge and compare visually perceived distances on paper.

Tests: Estimation of Length Test
Shortest Road Test
Nearer Point Test

Factor Ma: Associative (Rote) Memory

The ability to remember bits of unrelated material.

Tests: Picture - Number Test
Object - Number Test
First and Last Names Test

*Indicates factor measured in one or more curriculum
**Indicates test used to measure described factor

*Factor Mk: Mechanical Knowledge

The knowledge of mechanical principles, devices and tools, acquired through experience and training.

Tests:
- Tool Knowledge Test
- **Mechanical Information Test
- Electrical Information

Factor Ms: Memory Span

The ability to recall perfectly for immediate reproduction a series of items after only one presentation of the series.

Tests:
- Auditory Number Span Test
- Digit Span - Visual
- Letter Span- Auditory

*Factor N: Number Facility

The ability to manipulate numbers in arithmetical operations rapidly.

Tests:
- Addition Test
- **Subtraction and Multiplication Test
- Division Test

*Factor O: Originality

The ability to produce remotely associated, clever, or uncommon responses.

Tests:
- **Symbol Production
- Consequencies (remote)
- Plot Titles (clever)

*Factor P: Perceptual Speed

Speed in finding figures, making comparisons, and carrying out other very simple tasks involving visual perception.

Tests:
- Finding A's Test
- **Number Comparison Test
- Identical Pictures Test

*Indicates factor measured in one or more curriculum
**Indicates test used to measure described factor

*Factor R: General Reasoning

The ability to solve a broad range of reasoning problems including those of a mathematical nature.

Tests:
Mathematics Aptitude Test
**Ship Destination Test
Necessary Arithmetic Operations

Factor Re: Semantic Redefinition

The ability to shift the function of an object or part of an object and use it in a new way.

Tests:
Gestalt Transformation
Picture Gestalt
Object Synthesis

*Factor Rs: Syllogistic Reasoning

The ability to reason from stated premises to their necessary conclusions.

Tests:
Logical Reasoning
**Inference Test
Nonsense Syllogisms

*Factor S: Spatial Orientation

The ability to perceive spatial patterns or to maintain orientation with respect to objects in space. This factor seems to involve perception of the position and configuration of objects in space, perhaps best thought of as space with the observer himself as a reference point. These tests will be given under speeded conditions.

Tests:
Card Rotation Test
**Cube Comparisons Test
Spatial Orientation

Factor Sep: Sensitivity to Problems

The ability to recognize practical problems.

Tests:
Apparatus Test
Seeing Problems
Seeing Deficiencies

*Indicates factor measured in one or more curriculum
**Indicates test used to measure described factor

Factor Ss: Spatial Scanning

The speed in visually exploring a wide or complicated spatial field.

Tests: Maze Tracing Speed Test
Choosing a Path
Map Planning Test

***Factor V:** Verbal Comprehension

The ability to understand the English language.

Tests: Vocabulary I
Vocabulary II
Advanced Vocabulary I
****Wide Range Vocabulary Test**
Advanced Vocabulary II

***Factor Vz:** Visualization

The ability to manipulate or transform the image of spatial patterns into other visual arrangements. In this factor, the observer seems removed from the stimulus pattern in that he appears to manipulate and alter its image.

Tests: Form Board Test
Paper Folding Test
****Surface Development Test**

Factor Xa: Figural Adaptive Flexibility

The ability to change set in order to meet new requirements imposed by figural problems.

Tests: Match Problems II
Planning Air Maneuvers
Match Problems V

Factor Xs: Semantic Spontaneous Flexibility

The ability to produce a diversity of verbally expressed ideas in a situation that is relatively unrestricted. The emphasis of this factor is on change in kind of idea.

Tests: Utility Test
Alternate Uses
Object Naming

*Indicates factor measured in one or more curriculum
**Indicates test used to measure described factor

APPENDIX B

Description of Performance Tests

1. Plug and Ring Gauge Test

This test is used to measure the fine tactile kinesthetic sensitivity of students with respect to their ability to discriminate by feel between the different fits of plugs and rings. It is believed that through trade training in Automotive Mechanics; Air Conditioning, Heating and Refrigeration; Machinist; and Electrical Installation and Maintenance, students will be able to discriminate a skill in ranking the fits according to size in a manner superior to untrained students.

Three sets, each with five plugs and rings are used as the testing equipment. These metal plugs were machined so that when a standard one inch ring is placed on each a distinct fit is obtained. The task is to rank the five plugs according to size from largest to smallest. This is a rank-order test; the score will be the difference between the correct rankings and the students' rankings.

2. Measurement Pod Test

This test is administered to students in Machine Shop and Auto Mechanics and measures the degree of skill with which precise measurements can be made. A tactile kinesthetic sensitivity factor is also present because of the importance of "touch" and "feel" in performing these tasks.

The measurement pod is composed of fifteen gauge blocks connected in such a manner as to provide for four measurements using feeler gauges and four measurements using one and two inch micrometers.

The student is required to list his answers to the fourth decimal place, which involves interpolation in some of the cases. A time limit of six minutes

is imposed, and the score for the test is the absolute sum of the varances expressed as a whole number of ten thousandths of an inch.

3. Electrical Trouble-shooting Test for Automotive Mechanics

The object of this test is to measure the student's ability to locate and identify electrical malfunctions wherever they occur in the car's system.

A rectangular metal box, on which are mounted all the electrical components found in an automobile, was constructed so that by means of a switch panel, fourteen different electrical malfunctions can be introduced into the system. Circuits involving the ignition, head and tail lights, directional signals, parking lights and stop lights are used. A series of junction and fuse panels, externally mounted, provide the means by which the student can trouble-shoot the circuits at different points using a jump cable and probe.

The test is constructed so that the student responds to a written statement about a particular malfunction, i.e., statements are identical to those which might be voiced by a customer who describes what he thinks is wrong with his car. The student must locate and identify the trouble and give his answer to the test administrator who notes it on the answer sheet.

The score is the number of items done correctly within the twenty minute time limit.

4. Dynamometer Test

Accuracy with the dynamometer is used as one measure of kinesthetic sensitivity and has proven to be a reliable measure. It will be administered to skilled students in the Automotive Mechanics, Air Conditioning, Heating, and refrigeration; Machinist; and Electrical Installation and Maintenance curricula. The results will be compared with the unskilled students acting as a

control group. Both skilled and unskilled groups are divided into two groups, one with knowledge of results one without. While blindfolded, the subject is directed to exert pressure of 20 pounds by squeezing the dynamometer in his hand. The absolute variation over several trials is used as raw score.

5. Tactile-Kinesthetic Sensitivity Test

This is another approach to measure fine tactile-kinesthetic sensitivity through a newly developed piece of equipment. This test will be administered to students in Automotive Mechanics, Air Conditioning, Heating and Refrigeration, Machinist, and Electrical Installation and Maintenance. There is a push and pull rod suspended in a magnetic field. By increasing or decreasing the electrical input, the pressure required to move the rod will vary. The task is to compare a designated standard weight with a different weight by comparing the amount of pressure required to pull the rod at various field intensities. The subject must tell whether the pressure is higher or lower than the standard pressure.

6. Automotive Diagnostic Scope Test

This test is designed to measure the student's ability to diagnose ignition faults in an automobile engine using an analyzer scope. His ability to identify correctly the cause of malfunction by this method is considered an important facet of performance achievement in automotive mechanics. There are two forms of the test, static and dynamic. The static test uses a booklet of pictures of a scope screen and a question and answer sheet. The dynamic portion of the test employs the actual scope. By using an engine simulator, patterns identical to those listed on the static test booklet are imposed upon the screen. Although the items on each test are identical, they are not offered in the same

sequence nor are the multiple choice answers listed in the same order. In both parts of the test, each item is timed at thirty seconds. The score is the number of correct responses minus one third of the incorrect responses. After initial administration of the two forms, a comparison of reliabilities and the relationship between the two will be examined.

7. Auditory Achievement Test for Automotive Mechanics

Due to inability to get the necessary equipment this test is still in the process of development. It is being designed to measure the extent to which students in automotive mechanics can differentiate between normal and abnormal sounds encountered in automotive work. It will also attempt to measure the student's ability to identify certain sounds attributed to malfunctions. A high quality recording device will be used to record the audio input and play it back with binaural high fidelity. Procedures for this test have not been fully defined at this time.

8. Machine Indexing Test for Machinists

This test is designed to measure the tactile-kinesthetic sensitivity which is developed through Machine Shop training and which is necessary to perform certain tasks upon precision machine tools.

In the machine shop, the most up to date vertical or horizontal milling machine is used to demonstrate and measure the student's skills. Using only the cross feed screw, the subject must perform a series of ten movements, moving the table in and out according to instructions given verbally by the test administrator. An indicator mounted on the machine will reveal to the test administrator the results of the subject's moves. The score will be the total absolute variance of all ten moves.

9. Truing Test for Machinists

This test measures the learned eye-hand-mind coordination of students.

A plug of convenient diameter is placed in a four jaw chuck which is mounted in an engine lathe. Prior to the test, the plug is offset 1/16". The student must perform four tasks in a ten minute period. He must true the plug to within $\pm$ .0005 as task #1, task #2 is to offset the plug by 1/16" $\pm$ .0005; tasks #3 and #4 are the reverse of tasks #1 and #2. These tasks require that the student return the equipment to its original setting. This renders it ready for the next student.

This is a timed test. Each task is timed and noted on the score sheet provided. The score is the total time needed to accomplish the four tasks expressed as a whole number of quarter minutes. This score will inversely relate to the overall skill of the subject.

10. Auditory Achievement Test for Machinists

This is a performance test being developed for the machinist students along the same lines as the Auditory Test for Automotive Mechanics. The tasks in this test are for the machinist students to identify prerecorded danger sounds and machine malfunctions encountered in the machine shop. All these sounds are to be reproduced by the same high fidelity recording equipment used in the Automotive Auditory Test and described in 7. above.

11. Achievement Test for Television Servicing (Diagnosis of Television Malfunctions)

The task in this test is to diagnose the malfunctions of television which are presented by both static (pictures) and dynamic (TV Tester) methods. The TV Tester is a set designed so that over thirty different malfunctions can be switched in one at the time. One of the purposes of this test is to determine

whether or not the paper and pencil test (static presentation) can replace the performance test (dynamic presentation). Fifty items with thirty-two different malfunctions are included in the test. Four possible causes of malfunctions are given for each item and the student is required to select the one which most appropriately describes the audio and/or video malfunction in the actual act or as represented in the pictorial. Both static and dynamic tests have identical items and orders. The only difference is that one presents malfunctions by picture and the other by TV Tester. The time limit for this test is 50 minutes.

12. Systematic Comprehensive Review of Electrical Wiring

This is a performance test proposed for the students of the Electrical Installation and Maintenance. This achievement test is at the planning stage and not yet constructed. The idea of this test is to provide subjects with a large number of wires and equipment such as motors or control relays and let them set up circuits which will carry out the functions demanded. The accuracy and time used in completing the task will be considered as the criteria of success.